

CLAIMS

1. An apparatus for effecting a change in at least a portion of a selected site of a collagen containing tissue that is adjacent to an at least partially fluid medium, comprising:

an energy delivery device including a proximal portion and a distal portion configured to deliver sufficient energy to the selected site of a collagen containing tissue to effect a contraction in at least a portion of the selected site of a collagen containing tissue;

a sensor positioned at a the distal portion of the energy delivery device to detect a thermal energy from the selected site of a collagen containing tissue and at least a portion of the adjacent at least partially fluid medium, the sensor producing a thermal feedback signal which represents a composite of the thermal energy detected from the selected site of a collagen containing tissue and at least a portion of the adjacent at least partially fluid medium; and

a feedback control system coupled to the sensor and configured to receive the thermal feedback signal and adjust a level of energy delivered to the selected site of a collagen containing tissue.

2. The apparatus of claim 1, wherein the energy delivery device is constructed from platinum.

3. ~~The apparatus of claim 1, wherein the energy delivery device is constructed from stainless steel.~~

4. The apparatus of claim 1, wherein the energy delivery device is constructed from memory metal.

1 5. The apparatus of claim 1, wherein the energy delivery device is a
2 composite construction.

1 6. The apparatus of claim 5, wherein a component of the composite
2 construction does not conduct energy delivered by the energy delivery device.

1 7. The apparatus of claim 1, wherein the energy delivery device is an RF
2 energy delivery device coupled to an RF energy source.

1 8. The apparatus of claim 1, wherein the energy delivery device is a
2 resistive heating element coupled to a resistive heating source.

1 9. The apparatus of claim 1, wherein the energy delivery device is a
2 microwave probe coupled to a microwave source.

1 10. The apparatus of claim 1, wherein the sensor is a thermocouple.

1 11. The apparatus of claim 1, wherein the sensor is a thermistor.

1 12. The apparatus of claim 1, wherein the sensor is an optical coated fiber.

1 13. The apparatus of claim 1, further comprising:
2 a handle coupled to the proximal portion of the energy delivery device.

1 14. The apparatus of claim 1, further comprising:
2 an electrical insulator positioned at least partially around an exterior surface
3 of the energy delivery device.

1 15. The apparatus of claim 1, further comprising:

2 a thermal insulator positioned at least partially around an exterior surface of
3 the energy delivery device.

1 16. The apparatus of claim 1, further comprising:
2 an electrical insulator positioned at least partially around an exterior surface
3 of the energy delivery device and
4 a thermal insulator positioned at least partially around an exterior surface of
5 the energy delivery device.

1 17. The apparatus of claim 1, further comprising:
2 a thermally insulating material coupling the sensor to an exterior surface of
3 the distal portion.

1 18. The apparatus of claim 1, further comprising:
2 a thermally conductive material coupling the sensor to an exterior surface of
3 the distal portion.

1 *Sub 27* 19. *27* The apparatus of claim 1, wherein the sensor is positioned to detect a
2 thermal energy from substantially only the selected site of a collagen containing
3 tissue.

1 20. The apparatus of claim 1, further comprising a second sensor.

1 21. The apparatus of claim 1, wherein the sensor is a band at least
2 partially positioned on an exterior surface of the distal portion.

1 22. The apparatus of claim 1, wherein the sensor is positioned in an
2 interior of the distal portion of the energy delivery device.

1 23. The apparatus of claim 1, wherein the sensor is positioned on an
2 exterior surface of the distal portion and extends to an interior of the distal portion.

1 24. The apparatus of claim 1, wherein the distal portion is steerable.

1 25. The apparatus of claim 1, wherein at least a portion of the energy
2 delivery device is configured to be introduced through an operating cannula.

1 26. The apparatus of claim 1, wherein at least a portion of the distal
2 portion is hollow.

1 27. The apparatus of claim 26, wherein the distal portion has a
2 substantially uniform wall thickness.

1 28. The apparatus of claim 26, further including a potting compound
2 located in the hollow interior for positioning the sensor.

1 29. An apparatus for contracting a collagen fibers in a selected site of a
2 collagen containing tissue at least partially is adjacent to a fluid medium, comprising:
3 an energy delivery device including a proximal portion and a distal portion
4 configured to provide a selected thermal distribution in the selected site of a collagen
5 containing tissue and effect a controllable contraction of at least a portion of the
6 collagen fibers;

7 a sensor positioned at the distal portion of the energy delivery device; and
8 a feedback control system coupled to the sensor, wherein a position of the
9 sensor, a geometry of the distal portion of the energy delivery device and the
10 feedback control system provide a controllable energy delivery to the selected
11 containing tissue site.

1 30. A method for contracting a collagen fibers in a selected collagen
2 containing tissue site at least partially adjacent to a fluid medium, comprising:
3 providing an apparatus including an energy delivery device with a proximal
4 portion, a distal portion, a sensor and a feedback control system coupled to the
5 sensor;
6 delivering sufficient energy to the collagen containing tissue site to produce a
7 selected contraction of the collagen containing tissue site;
8 detecting a thermal energy at the selected collagen containing tissue site and
9 at least a portion of the adjacent fluid medium;
10 producing a thermal feedback signal which represents a composite of a
11 thermal energy of at least a portion of the selected collagen containing tissue site and
12 the adjacent fluid medium; and
13 adjusting a level of energy delivered to the selected collagen containing tissue
14 site.

1 31. The method of claim 30, wherein sufficient energy is delivered to
2 generate a selected thermal distribution in the selected a collagen containing tissue
3 site to effect a contraction of the collagen fibers irrespective of a temperature
4 differential between the collagen containing tissue site and the adjacent fluid medium

1 32. The method of claim 30, wherein the collagen containing tissue site is
2 a ligament.

1 33. The method of claim 30, wherein the collagen containing tissue site is
2 a joint capsule.

1 34. The method of claim 30, wherein the collagen containing tissue site is
2 a vascularized densely collagenous structure.

1 35. The method of claim 30, wherein the collagen containing tissue site is
2 a connective tissue.

1 36. The method of claim 30, wherein the feedback control system is
2 configured to be overridden by a surgeon.

1 37. The method of claim 30, wherein the level of energy is adjusted such
2 that a temperature at the selected site is maintained at about 45 to 75 degrees C.

1 38. The method of claim 30, wherein the level of energy is adjusted such
2 that a temperature at the selected site is maintained at about 45 to 65 degrees C.

1 39. The method of claim 30, wherein a level of energy applied to the
2 collagen containing tissue site is adjusted such that a temperature at the selected site
3 is maintained at about a desired temperature.

1 40. The method of claim 30, wherein the level of energy applied to the
2 collagen containing tissue site is adjusted such that a temperature at the selected site
3 is maintained at about a desired temperature for a desired time.

1 41. The method of claim 30, wherein the level of energy applied to the
2 collagen containing tissue site is adjusted such that overshoots are minimized.

1 42. The method of claim 30, wherein the adjacent fluid medium is at least
2 partially flowing.

1 43. The method of claim 30, wherein an energy applied to the collagen
2 containing tissue site is adjusted to minimize cell necrosis.

1 44. The method of claim 30, wherein an energy applied to the collagen
2 containing tissue site is adjusted to eliminate cell necrosis.

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